

[3.0011]

FURTHER OBSERVATIONS ON "FALSE BROODS"  
OF *COLIAS EURYTHEME* IN CENTRAL NEW YORK  
(LEPIDOPTERA: PIERIDAE)<sup>1</sup>

ARTHUR M. SHAPIRO<sup>2,3</sup>

The alfalfa caterpillar or orange sulphur butterfly, *Colias eurytheme* Boisduval, invaded the northeastern United States from the south and west in the late 1920's, establishing itself within a few years (Clark and Clark, 1951; Gerould 1946). In this part of its range it regularly produces "false broods" of fresh butterflies in November and December (Shapiro 1962, 1968). In 1961 alone, such flights were reported from Toronto, Ont. (Nov. 11); Frankfort, Ky. and Chicago, Ill. (last week of November); Knoxville, Tenn., Baltimore, Md., and Philadelphia, Pa. (first week of December) (Lepidopterists' Society, 1962, and various authors *in litt.*). They probably originate from pupae whose development had been arrested by cold; in the laboratory, such pupae may resume development and eclose rapidly under improved thermal conditions, at least for up to four weeks (Shapiro, 1968). This hypothesis is supported by an emergence at Ithaca, New York, reported below.

*November 23, 1968 Record.*— Central New York records indicate that *Colias* flight activity usually ends at the beginning of November, roughly four weeks after the first frost. This cutoff probably results from worsening weather which prevents eclosion and gradually kills off the unclosed pupae. Collecting at Ithaca, J. Keji took or saw his last *C. eurytheme* on the following dates: Nov. 15, 1949; Nov. 7, 1950; Oct. 26, 1951; Oct. 22, 1952. My last dates for 1966-1969 are Oct. 27; Nov. 12; Nov. 23, and Nov. 13 respectively. The 1968

---

<sup>1</sup> Accepted for publication February 7, 1970.

<sup>2</sup> Department of Entomology and Limnology, Cornell University, Ithaca, New York 14850.

<sup>3</sup> This research was supported in part by National Science Foundation grant GB 7757 (Environmental Biology).

record seems to be the latest for this region, and the circumstances surrounding it are of considerable interest.

The specimen collected on Nov. 23, 1968 is a very fresh female, and it was taken more than two weeks after the last preceding collection. As shown in fig. 1, a large flight of *C. eurytheme* and *C. philodice* Latrielle was in progress in late October. On Oct. 22, in mostly cloudy weather, only 1 male *C. eurytheme* and 1 female *C. philodice* were found. In sunny, warm conditions on Oct. 27, the catch was: 34 male, 4 female *C. eurytheme*, 15 male, 5 female *C. philodice*, 1 white female. I was unable to collect in good weather Nov. 1-2, but on Nov. 5 I took 30 males, 6 females *C. eurytheme*, 1 male *C. philodice*, and 5 white females. This flight was abruptly terminated by the onset of cold, wet weather Nov. 6. This persisted virtually uninterrupted through Nov. 22; a foot of snow fell on Nov. 17, 19, 20, and 21. Temperatures were rarely below freezing, however; the lowest reading during the period was 26° F.

Persistent overcast and temperatures too low for flight would be expected gradually to eliminate the adults in the fields, if only by starvation. At the

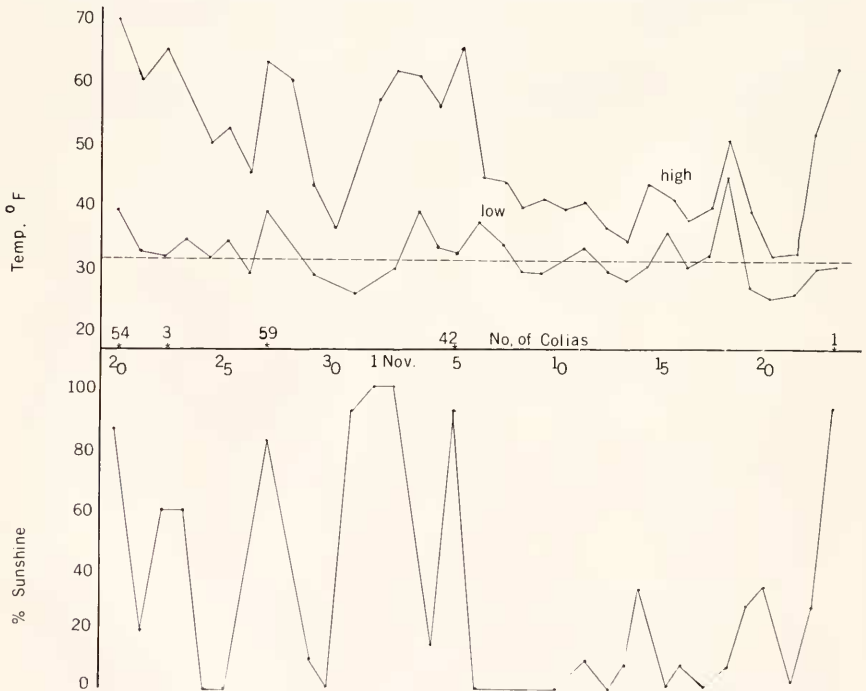


Figure 1. Weather conditions at Ithaca, N. Y. in October and November, 1968, and numbers of *Colias* spp. butterflies collected in two hours on flight days.

same time, the lack of a severe freeze, along with the insulation provided by the snow, suggested the possibility of a late emergence, given suitable weather; at least some arrested pupae would be expected to remain viable in such a regime. The Nov. 23 butterfly emerged after only 36 hours of continuous above-freezing temperatures, and only a few hours of sunshine. This makes it virtually certain that it was fully developed in the pupa and then arrested by cold.

*Survival of old butterflies, 1969.*— In 1968 some *Colias* taken in late October and early November were not fresh (Shapiro, 1968). Autumn, 1969 was generally unfavorable for *Colias*, and the main flight ended early (Fig. 2). Good numbers of both fresh and worn butterflies were flying on Nov. 20th. A cold front passed on Nov. 22nd, with overnight lows of 25, 23, and 25° F. on the next three dates. However, on Nov. 25th it warmed to 60° under clear skies, and a good sample of *Colias* spp. was taken. This consisted of: 15 male, 3 female *C. eurytheme* (6, 2 fresh); 6 male *C. philodice* (1 fresh); 1 white female. This sample thus consisted of 9 fresh individuals (36%) and 16 (64%) which had survived three successive hard freezes. Bad weather then returned. Again, the minimum temperature was reached the morning of a day with strong afternoon warming, Nov. 30th (temperature range 19 to 58°). On this date a sample was taken: 7 male, 4 female typical *C. eurytheme* (6, 2 fresh); 1 fresh female "chrome yellow" *C. eurytheme* (Clark and Clark, 1951); 1 male F<sub>1</sub> hybrid; 5 male *C. philodice* (2 fresh), and 1 fresh white female. Here 7 of 19 butterflies (37%)

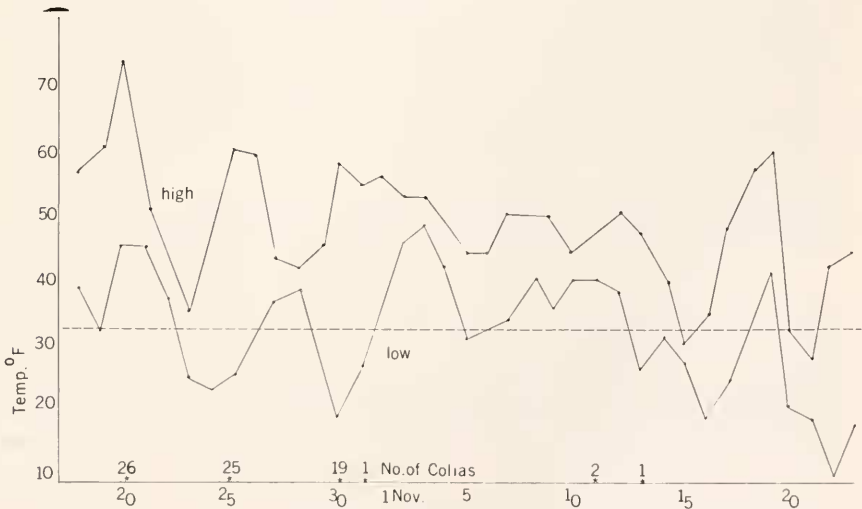


Figure 2. Weather conditions at Ithaca in October and November 1969, with two-hour *Colias* spp. collection totals.

had survived a minimum of one severe and 2 moderate freezes. The next day one old *C. eurytheme* male was taken in a strong wind with high, thin overcast. It was continuously overcast from the night of Oct. 31st through midday Nov. 11th. The temperature was above freezing nearly all of this time, and although some snow fell it did not persist. On Nov. 11th 2 fresh *C. eurytheme*, 1 of each sex, were taken at rest among sweet clover plants in near-overcast with temperature 47°. On Nov. 13th an old hybrid female was taken flying in sunshine at 47°. This butterfly had emerged before Nov. 11th, and perhaps as early as the end of October.

The condition of some of the butterflies taken Oct. 30th suggests they dated from before Oct. 25th, perhaps to Oct. 20th or earlier. This is particularly likely in one female which contained three spermatophores, indicating it had flown and mated on at least three different days. This specimen had lost about 20% of its wing surface, and the wings were badly descaled.

The early onset of cold weather, followed by nearly two weeks of cool, overcast conditions, seems to have prevented the usual late season emergence without being severe enough to kill the older insects quickly. A few days of sunny, mild weather at the end of the cool, cloudy period would probably have resulted in a major emergence. Instead, the weather deteriorated. It was mild on Nov. 18th, but partly cloudy and windy. Some emergence may have occurred, but no flight was observed.

*Reproductive potential.*— Stern and Smith (1960), studying the reproductive biology of *C. eurytheme* in California, found that newly emerged females showed a preoviposition period whose length was related to temperature and nutrition. At 10° C. (50° F.) the eggs matured slowly enough that the adult might die before ovipositing. Their insects were held at a constant temperature; outdoors late *Colias* sp. are subjected to highly variable temperatures, the biological effects of which may not be equivalent to constant exposure to their mean. The reproductive condition of 14 female *C. eurytheme* collected in good condition in October and November, 1967-1969, was therefore checked. Eleven of these had mated once, and one twice. Five of them contained mature eggs: 10, 11, 14, 35, and 107, the last with a few embryonated. None of these butterflies could have had more than 100 hours above 50° F., and most probably had much less. However, daily maxima may be substantially higher; and on sunny days, soil-surface temperatures may be much higher still. Stern and Smith obtained a mean of 50 mature ova/female after holding 51 hours at 25° C. (77° F.). In general, conditions permitting flight activity (Leigh and Smith, 1959; Watt, 1968, 1969) and mating are also highly favorable for egg maturation, but they must be sustained several days for effective reproduction to take place.

The old female collected Oct. 30, 1969 was ovipositing on red clover in the field. It was caged under continuous light indoors at 75° F. and provided with dandelions. Oviposition on sweet clover cuttings began sometime within 3 hours after caging, and continued until the insect died two days later. Of 118 eggs laid, 98 were fertile. There were less than 12 hours of air temperatures above 50° in the eight days preceding Oct. 30th.

In general, it seems safe to predict that even if eggs are laid, no offspring of "false broods" survive the winter at Ithaca except under very unusual circumstances.

#### Literature Cited

- Clark, A. H. and L. F. Clark. 1951. The butterflies of Virginia. Smithsonian Misc. Coll. 116 (7), 239 pp.
- Gerould, J. H. 1946. Hybridization and female albinism in *Colias philodice* and *C. eurytheme*. A New Hampshire survey in 1943 with subsequent data. Ann. Ent. Soc. America, 39: 383-396.
- Leigh, T. E. and R. F. Smith. 1959. Flight activity of *Colias philodice eurytheme* Boisduval in response to its physical environment. Hilgardia, 28: 569-624.
- Lepidopterists' Society. 1962. Annual summary for 1961. Lepid. Soc. News.
- Shapiro, A. M. 1962. *Colias* activity in November and December in Pennsylvania. Journ. Lepid. Soc., 16: 129-130.
- . 1968. The origin of autumnal "false broods" in common Pierid butterflies. Journ. Res. Lepid., 6: 181-193.
- Stern, V. M. and R. F. Smith. 1960. Factors affecting egg production and oviposition in populations of *Colias philodice eurytheme* Boisduval (Lepidoptera: Pieridae). Hilgardia, 29: 411-454.
- Watt, W. F. 1968. Adaptive significance of pigment polymorphisms in *Colias* butterflies. I. Variation of melanin pigment in relation to thermoregulation. Evolution, 22: 437-458.
- . 1969. Adaptive significance of pigment polymorphisms in *Colias* butterflies. II. Thermoregulation and photoperiodically controlled melanin variation in *Colias eurytheme*. Proc. Nat. Acad. Sci. (U.S.A.), 63: 767-774.

#### 2.0011 Further observations on "False Broods" of *Colias eurytheme* in Central New York (Lepidoptera: Pieridae).

Abstract.— The age structure of flights of *Colias eurytheme* in late autumn depends on weather conditions. Oviposition is possible even in November, but probably no progeny survive the winter in Central New York.— A. M. Shapiro, Department of Entomology, Cornell University, Ithaca, N. Y.

Descriptors: Lepidoptera; Pieridae; *Colias eurytheme*; false broods; Central New York.